Pull-in
- nonlinear springs
- finger pull-in

Pull-out
- relax

Fab

Gap closing actuator

\[ V_{gs} = \sqrt{\frac{x}{2z} \cdot \frac{K}{R}} \]

\[ g_{gs} = \frac{2}{3} g_0 \]

What about a nonlinear spring?

Electrostatics still wins eventually but pull-in gap, \( g_{gs} \), is smaller \( \Rightarrow \) more travel

Use stops to prevent shorting

Final gap \( g_e = g_0 - g_{stop} \)

Have to be careful of finger pull-in

Drawn

After gap is closed, new pull-in calc \( V_{gs} / g_f \)

Solve

\[ E \cdot I \cdot \frac{d^4 g}{dx^4} = \frac{1}{2} E \cdot I \cdot \frac{z}{g^2} \cdot f(x) \] for last equilibrium

\[ V^2 = \frac{0.28 E a^3 g_0^3}{E L^4 (1 + 0.02 \cdot \frac{a}{L})} \] (Osterbery & Vehe)
Relays
Separate a "shunt" and conduct from gap closing actuator.

Can we do this w/ polymers?

No easy way to make electrically isolated, mechanically coupled structures.

In the homework, they develop their own process so half there is an insulator.